Philips Semiconductors   **Product specification**

Logic level TOPFET   # PIP3122-R

DESCRIPTION

Monolithic logic level protected power MOSFET using **TOPFET2** technology assembled in a 5 pin surface mounting plastic package.

APPLICATIONS

General purpose switch for driving
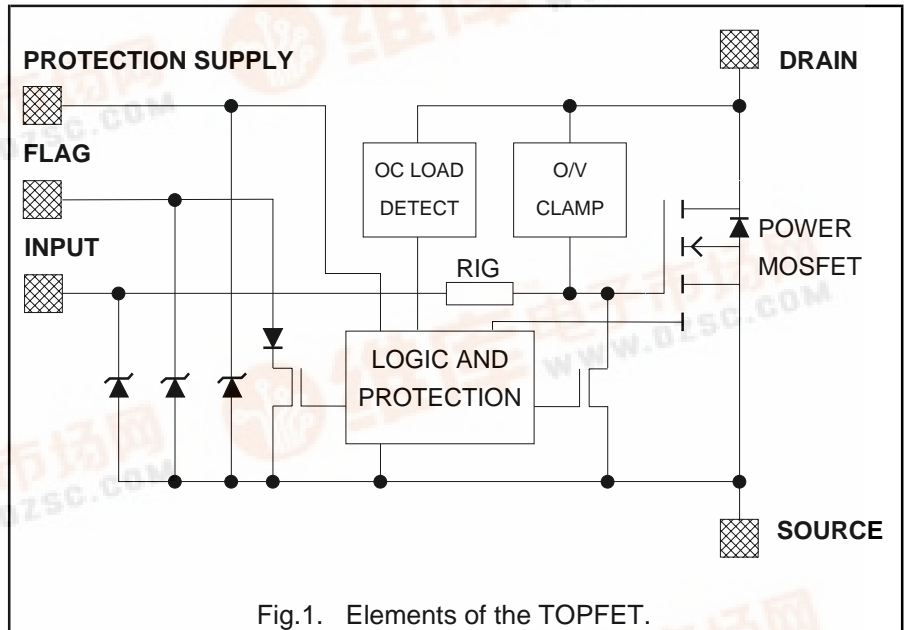- lamps
- motors
- solenoids
- heaters

FEATURES

- TrenchMOS output stage with low on-state resistance
- Separate input pin for higher frequency drive
- 5 V logic compatible input
- Separate supply pin for logic and protection circuits with low operating current
- Overtemperature protection
- Drain current limiting
- Short circuit load protection
- Latched overload trip state reset by the protection pin
- Diagnostic flag pin indicates protection supply connected, overtemperature condition,overload tripped state, or open circuit load (detected in the off-state)
- ESD protection on all pins
- Overvoltage clamping

QUICK REFERENCE DATA

SYMBOL	PARAMETER	MAX.	UNIT
V_{DS}	Continuous drain source voltage	50	V
I_D	Continuous drain current	40	A
P_{tot}	Total power dissipation	107	W
T_j	Continuous junction temperature	150	˚C
$R_{DS(ON)}$	Drain-source on-state resistance	20	mΩ

SYMBOL	PARAMETER	NOM.	UNIT
V_{PS}	Protection supply voltage	5	V

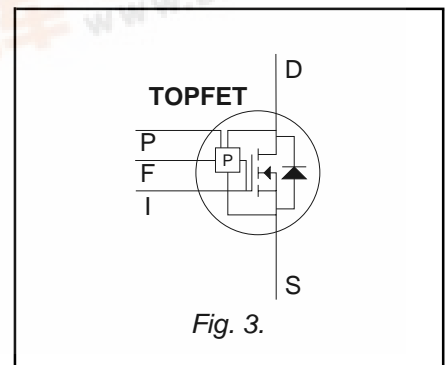## FUNCTIONAL BLOCK DIAGRAM

Fig.1.   Elements of the TOPFET.

PINNING - SOT426

PIN	DESCRIPTION
1	input
2	flag
3	(connected to mb)
4	protection supply
5	source
mb	drain

PIN CONFIGURATION

Fig. 2.

SYMBOL

Fig. 3.
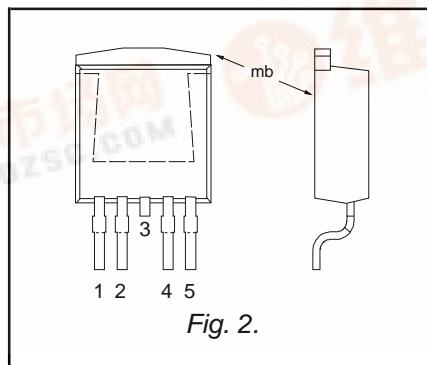
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LIMITING VALUES

Limiting values in accordance with the Absolute Maximum Rating System (IEC 134)

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
	Continuous voltage				
V_{DS}	Drain source voltage[1]	$V_{IS} = 0$ V	-	50	V
	Continuous currents				
I_D	Drain current	$V_{PS} = 5$ V; $T_{mb} = 25\,°C$	-	self - limited	A
		$V_{PS} = 0$ V; $T_{mb} = 80\,°C$	-	40	A
I_I	Input current		-5	5	mA
I_F	Flag current		-5	5	mA
I_P	Protection supply current		-5	5	mA
	Thermal				
P_{tot}	Total power dissipation	$T_{mb} = 25\,°C$	-	107	W
T_{stg}	Storage temperature		-55	175	°C
T_j	Junction temperature[2]	continuous	-	150	°C
T_{sold}	Mounting base temperature	during soldering	-	260	°C

ESD LIMITING VALUE

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_C	Electrostatic discharge capacitor voltage	Human body model; C = 250 pF; R = 1.5 kΩ	-	2	kV

OVERLOAD PROTECTION LIMITING VALUE

With an adequate protection supply connected, TOPFET can protect itself from two types of overload - overtemperature and short circuit load.

For overload conditions an n-MOS transistor turns on between the input and source to quickly discharge the power MOSFET gate capacitance.

The drain current is limited to reduce dissipation in case of short circuit load. Refer to OVERLOAD CHARACTERISTICS.

SYMBOL	PARAMETER	REQUIRED CONDITION	MIN.	MAX.	UNIT
	Overload protection[3]	protection supply			
V_{DS}	Drain source voltage	$V_{PS} \geq 4$ V	0	35	V

OVERVOLTAGE CLAMPING LIMITING VALUES

At a drain source voltage above 50 V the power MOSFET is actively turned on to clamp overvoltage transients.

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
	Inductive load turn off	$I_{DM} = 25$ A; $V_{DD} \leq 20$ V			
E_{DSM}	Non-repetitive clamping energy	$T_{mb} = 25\,°C$	-	550	mJ
E_{DRM}	Repetitive clamping energy	$T_{mb} \leq 95\,°C$; f = 250 Hz	-	60	mJ

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1 Prior to the onset of overvoltage clamping. For voltages above this value, safe operation is limited by the overvoltage clamping energy.

2 A higher T_j is allowed as an overload condition but at the threshold $T_{j(TO)}$ the over temperature trip operates to protect the switch.

3 All control logic and protection functions are disabled during conduction of the source drain diode. If the protection circuit was previously latched, it would be reset by this condition.

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THERMAL CHARACTERISTIC

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
	Thermal resistance					
$R_{th\ j-mb}$	Junction to mounting base	-	-	0.94	1.17	K/W

OUTPUT CHARACTERISTICS

Limits are for -40˚C $\leq T_{mb} \leq$ 150˚C; typicals are for T_{mb} = 25˚C unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
	Off-state	V_{IS} = 0 V				
$V_{(CL)DSS}$	Drain-source clamping voltage	I_D = 10 mA	50	-	70	V
		I_{DM} = 5 A; tp $\leq$ 300 µs; $\delta \leq$ 0.01	50	60	70	V
I_{DSS}	Drain source leakage current[1]	V_{PS} = 0 V; V_{DS} = 40 V	-	-	100	µA
		T_{mb} = 25˚C	-	0.1	10	µA
	On-state	$t_p \leq$ 300 µs; $\delta \leq$ 0.01; $V_{PS} \geq$ 4 V				
$R_{DS(ON)}$	Drain-source resistance	I_{DM} = 15 A; $V_{IS} \geq$ 4.4 V	-	-	40	mΩ
		T_{mb} = 25˚C	-	15	20	mΩ

INPUT CHARACTERISTICS

Limits are for -40˚C $\leq T_{mb} \leq$ 150˚C; typicals are for T_{mb} = 25˚C unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
	Normal operation					
$V_{IS(TO)}$	Input threshold voltage[2]	I_D = 1 mA	0.6	-	2.6	V
		T_{mb} = 25˚C	1.1	1.6	2.1	V
I_{IS}	Input current	V_{IS} = 5 V	-	16	100	µA
$V_{(CL)IS}$	Input clamping voltage	I_I = 1 mA	5.5	6.4	8.5	V
R_{IG}	Internal series resistance[3]	to gate of power MOSFET	-	1.7	-	kΩ
	Overload protection latched	$V_{PS} \geq$ 4 V				
I_{ISL}	Input current	V_{IS} = 5 V	1	2.7	4	mA

1 The drain current required for open circuit load detection is switched off when there is no protection supply, in order to ensure a low off-state quiescent current. Refer to OPEN CIRCUIT LOAD DETECTION CHARACTERISTICS.

2 The measurement method is simplified if V_{PS} = 0 V, in order to distinguish I_D from I_{DSP}. Refer to OPEN CIRCUIT LOAD DETECTION CHARACTERISTICS.

3 This is not a directly measurable parameter.

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PROTECTION SUPPLY CHARACTERISTICS

Limits are for -40˚C $\leq T_{mb} \leq$ 150˚C; typicals are for T_{mb} = 25˚C.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{PSF}	**Protection & detection** Threshold voltage[1]	I_F = 100 µA; V_{DS} = 5 V	2.5	3.45	4	V
I_{PS}, I_{PSL} $V_{(CL)PS}$	**Normal operation or protection latched** Supply current Clamping voltage	V_{PS} = 4.5 V I_P = 1.5 mA	- 5.5	210 6.5	450 8.5	µA V
V_{PSR} t_{pr}	**Overload protection latched** Reset voltage Reset time	 $V_{PS} \leq$ 1 V	1 10	1.8 45	3 120	V µs

OPEN CIRCUIT LOAD DETECTION CHARACTERISTICS

An open circuit load condition can be detected while the TOPFET is in the off-state. Refer to TRUTH TABLE.
V_{PS} = 5 V. Limits are for -40˚C $\leq T_{mb} \leq$ 150˚C and typicals are for T_{mb} = 25˚C.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I_{DSP}	Off-state drain current[2]	V_{IS} = 0 V; 2 V $\leq V_{DS} \leq$ 40 V	0.9	1.8	2.7	mA
V_{DSF}	Drain threshold voltage[3]	V_{IS} = 0 V	0.2	1	2	V
V_{ISF}	Input threshold voltage[4]	I_D = 100 µA	0.3	0.8	1.1	V

OVERLOAD CHARACTERISTICS

T_{mb} = 25˚C unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I_D $P_{D(TO)}$ T_{DSC}	**Short circuit load protection** Drain current limiting Overload power threshold Characteristic time	V_{PS} > 4 V V_{IS} = 5 V; -40˚C $\leq T_{mb} \leq$ 150˚C for protection to operate which determines trip time[5]	40 90 250	62 220 500	84 330 700	A W µs
$T_{j(TO)}$	**Overtemperature protection** Threshold temperature	V_{PS} = 5 V from $I_D \geq$ 4 A or V_{DS} > 0.2 V	150	170	-	˚C

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1 When V_{PS} is less than V_{PSF} the flag pin indicates low protection supply voltage. Refer to TRUTH TABLE.

2 The drain source current which flows in a normal load when the protection supply is high and the input is low.

3 If $V_{DS} < V_{DSF}$ then the flag indicates open circuit load.

4 For open circuit load detection, V_{IS} must be less than V_{ISF}.

5 Trip time $t_{d\,sc}$ varies with overload dissipation P_D according to the formula $t_{d\,sc} \sim T_{DSC}\,/\,\ln[\,P_D\,/\,P_{D(TO)}]$.

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TRUTH TABLE

For normal, open-circuit load and overload conditions or inadequate protection supply voltage.
Assumes proper external pull-up for flag pin. Refer to FLAG CHARACTERISTICS.

CONDITION	PROTECTION	INPUT	FLAG	OUTPUT
Normal on-state	1	1	0	ON
Normal off-state	1	0	0	OFF
Open circuit load	1	1	0	ON
Open circuit load	1	0	1	OFF
Short circuit load[1]	1	1	1	OFF
Over temperature	1	X	1	OFF
Low protection supply voltage	0	1	1	ON
Low protection supply voltage	0	0	1	OFF

KEY '0' equals low
'1' equals high
'X' equals don't care.

FLAG CHARACTERISTICS

The flag is an open drain transistor which requires an external pull-up circuit.
Limits are for -40°C $\leq T_{mb} \leq$ 150°C; typicals are for T_{mb} = 25°C.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
	Flag 'low'	normal operation; V_{PS} = 5 V				
V_{FSF}	Flag voltage	I_F = 100 µA	-	0.8	1	V
I_{FSF}	Flag saturation current	V_{FS} = 5 V	-	10	-	mA
	Flag 'high'	overload or fault				
I_{FSO}	Flag leakage current	V_{FS} = 5 V	-	0.1	10	µA
$V_{(CL)FS}$	Flag clamping voltage	I_F = 100 µA	5.5	6.2	8.5	V
	Application information					
R_F	Suitable external pull-up resistance	V_{FF} = 5 V	-	47	-	kΩ

SWITCHING CHARACTERISTICS

T_{mb} = 25°C; R_I = 50 Ω; R_{IS} = 50 Ω; V_{DD} = 15 V; resistive load R_L = 10 Ω.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$t_{d\ on}$	Turn-on delay time	V_{IS}: 0 V $\Rightarrow$ 5 V	-	1.8	5	µs
t_r	Rise time		-	3.5	8	µs
$t_{d\ off}$	Turn-off delay time	V_{IS}: 5 V $\Rightarrow$ 0 V	-	11	30	µs
t_f	Fall time		-	5	12	µs

1 In this condition the protection circuit is latched. To reset the latch the protection pin must be taken low. Refer to PROTECTION SUPPLY
CHARACTERISTICS.

MECHANICAL DATA

Plastic single-ended surface mounted package (Philips version of D²-PAK); 5 leads (one lead cropped)

SOT426

0   2.5   5 mm
scale
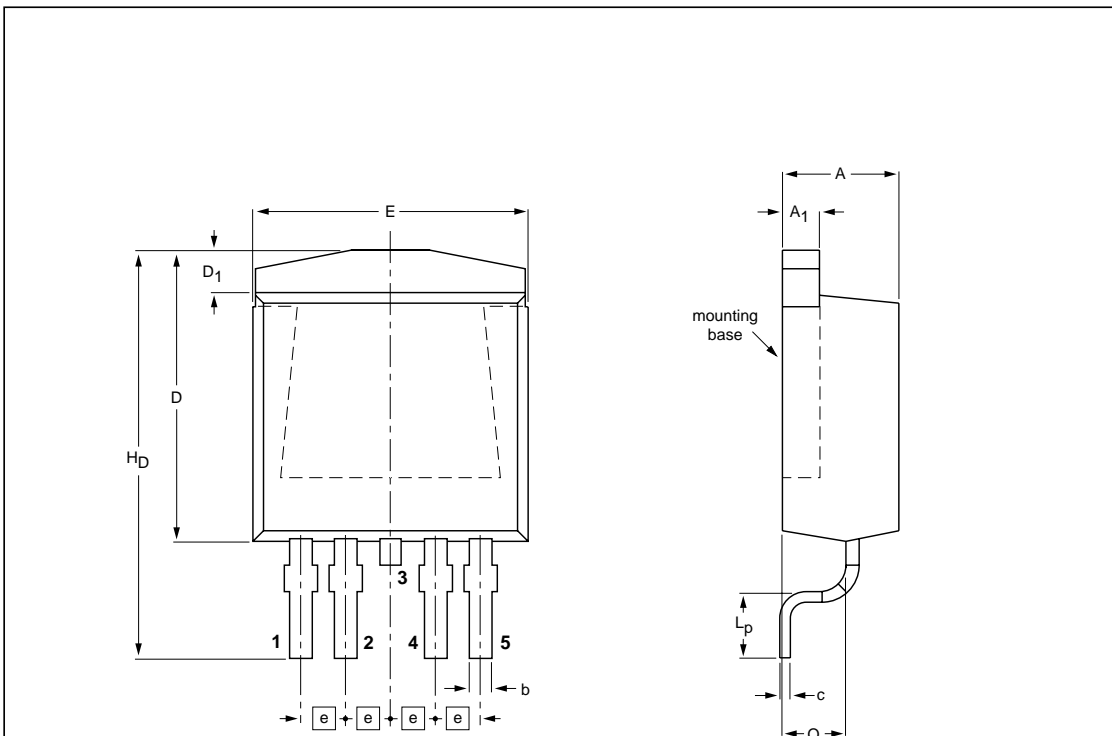
DIMENSIONS (mm are the original dimensions)

UNIT	A	A₁	b	c	D max.	D₁	E	e	Lp	HD	Q
mm	4.50 4.10	1.40 1.27	0.85 0.60	0.64 0.46	11	1.60 1.20	10.30 9.70	1.70	2.90 2.10	15.80 14.80	2.60 2.20

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT426						~~98-12-14~~ 99-06-25

Fig.4. SOT426 surface mounting package[1], centre pin connected to mounting base.

1 Epoxy meets UL94 V0 at 1/8". Net mass: 1.5 g.
    For soldering guidelines and SMD footprint design, please refer to Data Handbook SC18.

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DEFINITIONS

DATA SHEET STATUS		
DATA SHEET STATUS[1]	**PRODUCT STATUS**[2]	**DEFINITIONS**
Objective data	Development	This data sheet contains data from the objective specification for product development. Philips Semiconductors reserves the right to change the specification in any manner without notice
Preliminary data	Qualification	This data sheet contains data from the preliminary specification. Supplementary data will be published at a later date. Philips Semiconductors reserves the right to change the specification without notice, in order to improve the design and supply the best possible product
Product data	Production	This data sheet contains data from the product specification. Philips Semiconductors reserves the right to make changes at any time in order to improve the design, manufacturing and supply. Changes will be communicated according to the Customer Product/Process Change Notification (CPCN) procedure SNW-SQ-650A
Limiting values		
Limiting values are given in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of this specification is not implied. Exposure to limiting values for extended periods may affect device reliability.		
Application information		
Where application information is given, it is advisory and does not form part of the specification.		
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